

2

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

NTIS \$3.25

E7.2 - 1 0.3.6 7
CR-129800

BIMONTHLY REPORT FOR NAS5-21816
for the period October 1, 1972 - November 30, 1972

TASK 1 (UN 672) Correlation of Satellite and Ground Data in
Air Pollution Studies
Drs. G. E. Copeland and A. R. Bandy

TASK 2 (UN 628) Investigation to Relate Chlorophyll and Suspended
Sediment Content in the Waters of the Lower Chesapeake Bay
to ERTS-1 Imagery
Drs. Fleischer (Ludwick), Hanna, Gosink and Bowker

TASK 3 (UN 673) The Use of ERTS-1 to More Fully Utilize and Apply
Marine Station Data to the Study of Productivity along
the Eastern Shelf Expanded Waters of the United States
Dr. H. G. Marshall

Management Summary

Submitted to the
Goddard Space Flight Center
National Aeronautics and Space Administration

By the

Old Dominion University Research Foundation
Old Dominion University
Norfolk, Virginia 23508

(E72-10367) [USE OF ERTS IMAGERY IN AIR
POLLUTION AND MARINE BIOLOGY STUDIES,
TASKS 1 THROUGH G.E. Copeland, et al
(Old Dominion Univ. Research Foundation)
30 Nov. 1972 22 p

N73-14355

CSSL 08A

G3/13

Unclas
00367

TASK 1 (UN 672)

Dr. G. E. Copeland

and

Dr. A. R. Bandy

CORRELATION OF SATELLITE AND GROUND
DATA IN AIR POLLUTION STUDIES

December 15, 1972

Abstract

A survey of imagery up to 18 August yields many sources of particulate air pollution in the U.S.A. Preliminary interpretation of the Alaskan Forest Fire, and San Francisco Bay area is discussed. Analysis of ERTS imagery of Chesapeake Bay Region for 22, 23 Sept. and 10, 11 Oct. 1972 yields several jet contrails, area plume sources (power plants) and open burning.

INTRODUCTION

The following is a report of the progress of a NASA sponsored air pollution study of Hampton Roads Virginia utilizing Earth Resources Technology Satellite products. The report is an indication of work conducted from 15 September to 15 December 1972 by a research group at Old Dominion University.

INTRODUCTION

SECTION I

Microfilm Imagery Review (prior to 18 August)

- A. U.S. catalogue
- B. Non U.S. catalogue

SECTION II

Selected areas outside of Chesapeake Bay (CARETS)

- A. Alaskan Forest Fire
- B. San Francisco Bay
- C. Other Related Areas

SECTION III

Preliminary Analyses of Imagery of the Chesapeake Bay Area

- A. U-2 imagery evaluated for use with ERTS imagery
- B. ERTS - Prior to 03 September 1972
- C. ERTS - 22 & 23 September 1972
- D. ERTS - 10 & 11 October 1972
- E. ERTS - 27, 28, & 29 October 1972

SECTION IV

Conclusions

Section I
Microfilm Imagery Review

U.S. and Non U.S. Catalogues to 18 Aug.

A. Continental United States

Preliminary review of microfilm images for U.S. catalogue prior to 18 August yielded indications of haze (H), contrails (C), or point sources (PS) for suspended particulate matter on the following images:

image ID	microfilm reference	Type
1002-16332	0006	PS, H
1002-18134	0021	UNK
1003-14503	0035	C, H
1003-16332	0051	C, H
1003-16350	0059	C, H
1003-21350	0103	C, H
1003-21355	0107	PS
1005-15005	0154	C, H
1005-15011	0156	C, H
1005-15014	0158	C, H
1005-16431	0176	H, UNK
1009-17055	0195	H, PS
1009-17073	0199	PS
1010-15333	0214	C, H
1002-16300	0238	H
1004-18230	0284	C
1007-15140	0410	C, H
1007-16531	0428	H
1008-15203	0464	C, H

From the above images, the following five were chosen for more detailed analysis on the basis of probability and applicability to East coast smoke plume and point source occurrences:

1003-14503; 1005-15011; 1010-15333; 1007-15140; 1008-15203

(See Section II C).

B. Non U.S. Catalogue

Preliminary review of microfilm images for non U.S. catalogue prior to 18 August also yielded indications of haze, contrails, or point sources for suspended particulate matter. No attempt will be made at present to list these images since our primary interest area is North America.

Section II

Selected areas outside of Chesapeake Bay were chosen for study because they display characteristics which could be related to the study of air pollution in the Bay area. The study also provided an opportunity to compare the various ERTS products to determine which were more suitable for our purpose.

A. Alaskan Forest Fire 1003-21355 MSS 4, 5, 7 color composite print.

Receipt and analyses of this image was the first opportunity for this group to determine scale factors, measurable ground size (resolution) and characteristics of shape, size and color signature for suspended plumes.

The area of interest is approximately 90 square nautical miles of burned and burning forest. There is a prevailing east wind. Five distinct plumes originate from the western edge of the burned area. All displayed different shapes, sizes and color intensities. The longest plume extends⁰ westward some 35 nautical miles from the fire source. It appears to be a classical conical plume originating in a point source. The area of that source is determined to be approximately 1350 sq. ft. This measurement can give only an indication of the actual fire area, as dispersion takes place before the plume drifts horizontally due to the prevailing wind. The plumes appear grey white distinctly different from clouds. A dense blue register occurs near each point source. As the plume is extended and thinned, a register of light blue to grey occurs. The latter is most likely due to diffraction of the

blues from points on the ground under the plume. Similar registers occur on the edges of clouds in the same area. The dense blue register near the point source, however, could be a characteristic of fire plumes. More imagery with correlated ground data will help in determining this.

The differences in sizes and shapes of the various plumes is due primarily to effects of topography and extent of the area of the source.

B. San Francisco Bay 1003-18175 Bands 1-7

The San Francisco Bay area simulates a densely populated microcosm of the Chesapeake Bay area. The topography of the lower San Francisco Bay approximates that of its East coast counterpart.

The 70 mm black and white imagery is of limited value in the detection of plumes. The format at that scale limits the determinations of size, shape and location due to film resolution. The black and white mode, of course, limits color characteristics of the image to intensity registers. In spite of these limitations indications of smoke plumes in the lower Bay and the Oakland side of the Bay were detected.

C. Other Related Areas

9 x 9 black and white MSS transparencies were ordered from the following areas: Providence, Rhode Island; Long Island, New York; Gainesville, Florida; Eastville, North Carolina; Georgetown, South Carolina. All of these frames depict eastern coastlines, and indications of haze, plumes or contrails.

We are still awaiting receipt of these image products!

Our purpose for acquiring imagery of these selected areas is threefold:

1. To place the problems of air pollution in the Chesapeake Bay in the proper perspective in relation to similar communities on the Eastern Seaboard,
2. To establish a standard against which to judge the nature and extent of particulate haze and plumes,
3. To judge the effectiveness of ERTS 9 x 9 black and white transparencies in detecting air pollution over water in Eastern Seaboard communities similar to the Chesapeake Bay area.

Section III

Preliminary analyses of imagery of the Chesapeake Bay area.

A. U-2 imagery evaluation; mission no. 71-032, CARETS,
15 Sept. 1971

A plot of the flight path of this mission on a chart scaled at 1:1,000,000 proved to be of great service to us. It enables us to get a close look at areas of particular interest defined on ERTS imagery. It is an invaluable supplement to standard aeronautical and topographical charts. A plume picked up on ERTS imagery may describe a point encompassing several city or suburban blocks. Chart information is not detailed enough to permit elimination of any block sections. The U-2 imagery allows us to closely scrutinize the area, permitting speculation on the likelihood of any given section (within the parameters defined by the ERTS observation) being the source of the plume; thereby aiding us in the collection of ground data on subsequent missions.

On one occasion a plume was located on ERTS imagery in the highly industrialized area between Richmond and Petersburg, Virginia. The same area viewed on U-2 imagery indicated a heavy plume and haze in the same area (a year earlier). This enabled us to positively determine the source, the nature of the plume and to assign appropriate characteristics (See Section III C).

B. ERTS Prior To 03 September 1972

MSS Bands 4 through 7 black and white positive 9.5 inch transparencies, and 70 mm black and white positives and negatives.

18 August imagery (1026-15194) yielded indications of possible

plumes originating on the eastern bank of the Nansemond River north of Kings Rd. Bridge. The outline registered clearly on Bands 4 and 5, lessening in intensity and definition on Bands 6 and 7. This is a characteristic that will occur again (See section III C, D and IV). At this stage of our operation, sufficient ground data to absolutely determine the nature of this register, was not available.

Cloud cover at this date had precluded analysis of our primary area of interest.

C. 22 and 23 September 1972

MSS Bands 4 through 7 black and white positive 9.5 inch transparencies and 70 mm black and white positives and negatives.

What land area was visible through clouds on 22nd of September imagery, yielded no positive indications of plumes. Some low lying haze was apparent near shore lines.

Image 1062-15193 (23 September) centered over Richmond, Virginia, was our first opportunity to positively identify a ground originated plume prior to evolving corroborating ground data. Two distinct plumes are imaged near Chester, Virginia (between Richmond and Petersburg) and a third is centered just north on the James River. Three distinct aircraft contrails are imaged with shadows. All are over 50 nautical miles long. Four other possible point sources are visible. Quality and resolution of this image is excellent. Cloud cover is nominal.

Although analysis of this imagery is not complete, the following is submitted:

1. Designated plume A - the most prominent cone shaped plume of bright intensity centered just outside the city of Chester, due east. Its length is greater than 12,000 ft. and 2200 ft. at its widest. Possible sources are being investigated by the Virginia State Air Pollution Control Board. Nature unknown. It displays a characteristic increase in definition of shape as it is imaged closer to band seven. The point of the plume encompasses an area approximate to a circle with radius 400 ft. centered at N 37° 20'57" W 77° .24'50".
2. Designated Plume B - located some 5,000 feet west northwest of the center of the circle described for plume A. This plume appears less dense. Nature unknown. It is greater than 8,000 feet long, and 800 feet wide.
3. Designated plume C - this plume is located over a VEPCO power plant on an oxbow of the James River between Richmond and Petersburg. It is an oilburning plant. A similar plume was evidenced on U-2 photography acquired a year earlier on a Chesapeake Bay CARETS flight. The plume is circular, large (5,500 ft. diameter) and dense in its center, dispersing toward the edges. This plume is present on subsequent ERTS imagery (see section III D).
4. Contrails - the contrails are designated A, B, and C, with A the westernmost image. All the contrails are approximately 5,000 ft. wide. B and C are between 26 and 27 thousand feet high. A is between 32 and 33 thousand feet high.

D. 10 and 11 October 1972

MSS Bands 4 through 7 black and white 9.5 inch positive transparencies and 70 mm black and white positives and negatives.

Image 1079-15140 (10 October) centered over Chesapeake Bay revealed one prominent plume centered over the Barrets corner area of Virginia Beach. The plume was conical and extended some 3800 feet. It was 500 feet at its widest and less than 500 feet high. Subsequent investigation revealed that a construction company burned a significant amount of scrap at Barret's corner on the morning of that date.

Three smaller plumes were located in the heavily industrialized area on the Eastern Branch of the Elizabeth River.

Haze and the possibility of plumes were noted over the Norfolk Naval Base (NOB).

Analysis of this image is not complete. A color composite has been requested.

Image 1080-15194 (11 October) centered over Richmond, Virginia revealed a plume over 17,000 ft. long and 3,000 ft. at its widest, originating at a location corresponding to a VEPCO plant on the James River between Richmond and Petersburg (the same one associated with Plume C in section III C). This plume appeared conical and dense at its source, dispersing as it lengthened. The edge of its general outline became more defined as it was imaged closer to band 7. Analysis of this image is not complete.

E. 27, 28 & 29 October 1972 - Chesapeake Bay was not imaged in this series. Cloud cover on imagery of bordering areas precluded

extensive analysis. No clear indications of plumes, ground originated haze or contrails were evidenced on the visible land area.

Section IV

Conclusions

The general suitability of ERTS imagery in detecting ground originated air pollution has proved to be excellent. The quality and resolution exceeded our expectations and has enabled us in some instances to locate point sources to within a thousand feet. Positive identification of plumes less than a quarter mile in length is possible. As yet we have not developed suitable techniques for determining or measuring area and line sources of air pollution, however we expect to make some progress in those areas as our ground data collection techniques are expanded. As our file of ERTS products increases, comparative studies in these areas become possible.

We are still in the process of expanding our ground data collection techniques to include the acquisition of correlating photography in black and white, color and infrared acquired from selected points in Tidewater. We also anticipate two related projects scheduled for completion in the near future to enhance the data available to us. Those projects are: 1. the construction of a tower on campus to acquire multilevel atmospheric data and 2. the construction of a mobile van capable of monitoring levels of particulates SO_2 , CO , O_3 , etc. at different points in the city.

The major problem has been, of course, cloud cover that has persisted over our area of primary interest (Chesapeake Bay). To date, only the 10 October imagery has been of sufficient quality to enable us to look at Norfolk, Virginia Beach and Newport News to any extent.

TASK 2 (UN 628)

Dr. P. Fleischer
(Dr. J. C. Ludwick)
Dr. W. J. Hanna
Dr. T. A. Gosink
Dr. D. W. Bowker

INVESTIGATION TO RELATE THE CHLOROPHYLL AND
SUSPENDED SEDIMENT CONTENT IN THE WATERS OF
LOWER CHESAPEAKE BAY TO ERTS-1 IMAGERY

ERTS 1, TASK 2

Bimonthly report for period ending November 30, 1972

During October, work continued on the mounting for the continuously recording transmissometer. The R/V LINWOOD HOLTON was in drydock for annual maintenance and overhaul during this month, and the drydocking was used to design the mounting. The completed transmissometer system is now operational, and consists of a keel-mounted transmissometer and an on-deck continuous recorder. The instrument is attached to the keel by two SCUBA divers before the start of a cruise and removed the same way at the termination of the cruise. Operational speed with the instrument is presently 6-knots, and this speed allows coverage of about 50 nautical miles during a six-hour period bracketed about an ERTS overpass.

No transmissometer cruises were made during the October 10 and 28 overpasses because of the abovementioned drydocking of the HOLTON. An attempt to make a run during the November 15 overpass had to be aborted because of rough seas. An instrument testing and shakedown cruise was successfully completed on December 1.

The cruise for the December 3 overpass was completed with 100 percent success, and light transmission in surface waters of Lower Chesapeake Bay was continuously recorded along approximately 40 miles of transects during the ERTS overpass under clear skies.

MSS images for the October 10 overpass have been received. Computer data requested have not been received. Two lane bridges over rivers show clearly especially in bands 5&6. These bands also clearly show flood water sediments in the James River.

TASK 3 (UN 673)

Dr. H. G. Marshall

THE USE OF ERTS-1 TO MORE FULLY UTILIZE AND
APPLY MARINE STATION DATA TO THE STUDY OF
PRODUCTIVITY ALONG THE EASTERN SHELF EXPANDED
WATERS OF THE UNITED STATES

ERTS 1, TASK 3
Bimonthly report for period ending November 30, 1972

1. Water collections were made aboard the National Marine Fisheries Service vessel DELAWARE II during July and August 1972 at 50 water stations. Stations were located over the continental shelf of the eastern United States between Cape Cod and Florida.
2. The water samples were obtained for phytoplankton analysis. Sea truth data obtained at each station included surface chlorophyll, temperature, and salinity.
3. Examination of plankton samples have begun at the biology laboratory of the principal investigator.
4. Data products from the ERTS program have been received and examined at the Old Dominion University Earth Resources Image Analysis Laboratory.
5. Preparations for the forthcoming sea collections in January-February are underway. Water samples will be taken at the same station sites during this period.

MANAGEMENT SUMMARY

No additional personnel changes are contemplated at this time.

Funds available for the conduct of the project are sufficient though some modification of categorical expenditures are contemplated to more effectively discharge the responsibilities of the contract. Should a need for reprogramming of funds or for additional funds arise, the changes will be discussed in advance with the NASA technical monitor.